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ON-FARM PULSE CROP GERMPLASM EVALUATION

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FINAL REPORT TO
SASKATCHEWAN PULSE GROWERS &
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"On-Farm Pulse Crop Germplasm Evaluation"

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SPG Project: BRE0405
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a) Summary

The rapid expansion of the pulse industry including diversification into many market classes has resulted in expansion of breeding programs. This has led to problems of land management at research station screening sites and the need for evaluation of breeding lines in target environments. We overcame these problems by designing a flexible, low unit cost breeding system based on on-farm screening in key environments. Obvious deficiencies in the CDC pulse breeding testing program in the early part of this decade were detected as follows: dry bean in SE Saskatchewan, lentil and pea in the Regina plain and the acid soil region of west-central Saskatchewan, and pea in the short-season Parkland region. This five-year project, which began in the 2004 season, addressed these deficiencies using an on-farm pulse crop germplasm testing approach. This report summarizes the research activities in 2008. The activities in the 2004-2007 seasons were summarized in previous annual reports.

Pulse crop breeding lines were arranged into standard yield trials. F4-F7 generation lines were evaluated in 2008 trials. Only one or two crops were evaluated per location to increase the efficiency of trial maintenance. At each location, nurseries were established in pulse growers' fields of the corresponding crop. Planting date closely coincided with the growers' planting date. Nurseries were arranged in a manner that allowed the grower to apply herbicides and fungicides to pulse plot areas using large-scale equipment, thus reducing the number of visits to the sites by the CDC pulse crop breeding crew, and therefore, reducing the per plot cost.

Nurseries were conducted at the following locations in 2008, with the following growers:
Dry bean at Oxbow (Wayne Amos)
Field pea at Meath Park (Kevin Skragg)
Lentil and field pea at Pasqua (Harvey Marcil)
Lentil and field pea at Wilkie (Adam Davey)

A total of 7839 plots were evaluated in 2008 at a cost of approximately $10 per plot. The Pasqua site was substituted for the Rouleau site in 2008. The Pasqua site provided a similar soil type and saved one hour of travel time per round trip. In general, growing conditions resulted in above average yields of pea and lentil with average grain quality. Rainfall conditions were above average resulting in good growing conditions. Trials at all four locations provided valuable data for selecting superior lines for 2009 trials.

b) Methods

Introduction

Criticisms of small plot screening trials from the grower perspective include:

1. Trials are conducted in sheltered environments within research stations,
2. Trials are not conducted using current grower technology.

From the perspective of pulse crop researchers, research station locations for trials are also problematic because:

1. Timing of seeding is influenced by availability of shared personnel and equipment,
2. Land restrictions and rotations dictate the location of trials, often increasing the risk of herbicide drift, soil residues, and unintentional disease outbreaks.

At the same time, the rapid expansion of the pulse industry has led to diversification into many market classes, leading to expansion of breeding programs. For example, the lentil program at the CDC must accommodate at least three sizes of green lentil, French green, Spanish brown, and three sizes of small reds in order to satisfy customer demands. The field pea program at the CDC must accommodate yellow and green cotyledon types for various food markets, the feed market for monogastric animals, the birdseed market, the marrowfat market, and the forage market for ruminants. This has led to problems of land management at research station screening sites.

We proposed to overcome these problems by designing a flexible, low unit cost breeding system based on on-farm screening in key environments.

Effective plant breeding requires regional testing of preliminary and advanced lines over several years and locations in order to select varieties with good performance, i.e., improvements in yield, disease resistance, lodging resistance, early maturity and market quality. The pulse crop breeding program at the CDC typically evaluates lines within a 150 km radius of Saskatoon. Key sites are located in Saskatoon, Rosthern, Elrose, Kyle, and Outlook. However, pulse crops are grown throughout the agricultural regions of Saskatchewan in diverse agricultural ecosystems. Thus, we were not adequately evaluating breeding lines in their target areas of production.

Obvious deficiencies detected were as follows. The Regina plain is a key pulse growing region for lentil and field pea. We were not testing in this area. Field pea is

grown extensively in the short-season Parkland region which requires early maturity and high yield under cooler conditions. We were not effectively testing in this area. Large portions of west-central Saskatchewan have acid soils. We were not testing in this area. The dry bean industry is developing in SE Saskatchewan. We were not testing in this area.

This project provided valuable data for selection of superior pulse crop varieties for Saskatchewan growers. Key features of this type of on-farm evaluation are:

1. The plots are treated the same as the farmer's crop, allowing more realistic evaluation,
2. The same sites and methods can be used for regional trials.

c) Progress during the reporting period

Objectives:

1. Use on-farm environments to evaluate pulse crop breeding lines.
2. Reduce the per unit cost of breeding line evaluation to allow more efficient screening of the many pulse market classes.

Hypotheses to be tested:

1. On-farm environments can be successfully utilized to evaluate pulse crop breeding lines.
2. The per unit cost of breeding line evaluation can be reduced using an on-farm evaluation approach.

Research Plan/Approach:

From 2004 to 2008, key target environments were used to improve on-farm screening of pulse crop breeding lines. Pulse crop breeding lines were arranged into standard yield trials for evaluation in key target environments in Saskatchewan: southeastern Saskatchewan, the Regina plains, short season Parkland, and the acid soils area. Only one or two crops were evaluated per location to increase the efficiency of trial maintenance. At each location, nurseries were established in pulse growers' fields of the corresponding crop. Planting date closely coincided with the growers' planting date. Nurseries were arranged in a manner that allowed the grower to apply some of the herbicides and fungicides to pulse plots using large-scale equipment, thus reducing the number of visits to the sites by the pulse crop breeding crew, and therefore, reducing the per plot cost.

Nurseries were conducted at the following locations, with the following growers:
Dry bean at Oxbow (Wayne Amos)
Field pea at Meath Park (Kevin Skragg)
Lentil and field pea at Pasqua (Harvey Marcil)
Lentil and field pea at Wilkie (Adam Davey)

At the F4 level, we typically evaluated one rep in Saskatoon nurseries and a second rep at an on-farm site. Having two sites improves the chances that at least one will

be a low disease site, which will be used as planting seed for F5 trials. A low disease site greatly reduces cleaning costs in F5 seed set-up.

Plot size was typically 4-rows with 12 foot row length and 1 foot row space. Plots were planted with small plot planters and harvested with small plot combines. Alleys were trimmed using glyphosate applied with a small tractor-mounted shrouded sprayer.

The pulse crew traveled to the nurseries for planting, trimming alleys, some pesticide applications, and harvest. Breeders visited each site once or twice per season for note-taking. Data were analysed immediately following harvest and used in key decisions regarding release of new varieties, increase of breeder seed, and advancing lines to 2008 trials.

Results

In the grant proposal leading up to this project the anticipated trials and sites were summarized as follows in Table 1.

Table 1. Example of pulse crop lines to be evaluated at four large-scale, on-farm sites in Saskatchewan

		F4				F5				F6-F8				Total plots per
Site	Crop	trials	entries	reps	plots	trials	entries	reps	Plots	trials	entries	reps	plots	crop/site
Oxbow	dry bean	12	81	1	972	10	36	2	720	4	36	2	288	1980
Rouleau	lentil	12	81	1	972	10	36	2	720	5	36	2	360	2052
	pea	0	0	0	0	10	36	2	720	3	36	2	216	936
Smeaton	pea	12	81	1	972	10	36	2	720	3	36	2	216	1908
Wilkie	lentil	0	0	0	0	10	36	2	720	5	36	2	360	1080
	pea	0	0	0	0	10	36	2	720	3	36	2	216	936
Grand total														8892

The actual trials planted in this project in 2008 are summarized in Table 2. The distribution of trials was modified slightly from the grant proposal but the total number of plots evaluated was similar to that proposed.

Table 2. CDC pulse crop lines evaluated at four large-scale, on-farm sites in Saskatchewan in 2008

		F4				F5				F6				F7				Total plots per
Site	Crop	trials	entries	reps	plots	trials	entries	reps	plots	trials	entries	reps	plots	trials	entries	reps	plots	crop/site
Oxbow	dry bean	0	0	0	0	6	18-36	2	396	1	36	2	72	1	27	3	81	549
Pasqua	lentil	8	45-81	1	612	13	36	2	936	2	36	2	144	3	18-36	3	234	1926
	pea	0	0	0	0	10	18-36	2	684	4	36	2	288	0	0	0	0	972
Meath Park	pea	14	81	1	1134	10	18-36	2	684	4	36	2	288	0	0	0	0	2106
Wilkie	lentil	0	0	0	0	13	36	2	936	2	36	2	144	3	18-36	3	234	1314
	pea	0	0	0	0	10	18-36	2	684	4	36	2	288	0	0	0	0	972
Grand total																		7839

In general, the trials conducted at Meath Park, Pasqua, Wilkie and Oxbow were as reliable as the CDC trials grown at more local sites (Sutherland, SPG and Skarsgard (all three in the Saskatoon area), Outlook, Kyle, Elrose and Rosthern) for the respective crops, as evidenced by their coefficients of variation (CV) for yield (see Tables 3-5).

Table 3. Summary of coefficients of variation (CV) for yield and yield (kg/ha) in CDC pea advanced and elite trials in 2008

	Pasqua		Sutherland		Rosthern		Meath Park		Wilkie		Outlook		Elrose		SPG	
Test	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha
PAYT 01	5.0	1705	6.6	2866	12.2	2813	8.3	2888	12.6	3747						
PAYT 02	12.5	1709	4.4	3449	10.2	3143	9.5	3056	12.0	4010						
PAYT 03	10.7	1360	4.1	3446	11.3	3201	8.4	2656	12.5	4011						
PAYT 04	6.1	1896	6.9	3321	12.2	3150	6.9	2757	8.3	3929						
PAYT 05	6.1	1697	6.5	3352	8.5	2604	8.4	2675	6.3	3948						
PAYT 06	11.8	1254	5.6	3530	8.2	3037	8.6	2558	14.0	3903						
PAYT 07	9.5	1560	6.0	2834	12.0	2790	7.6	2569	8.6	3345						
PAYT 08	9.5	1560	5.2	3022	9.6	2815	12.4	2382	9.1	3055						
PAYT 09	8.1	2437	4.1	3170	6.1	2684	6.6	3254	6.6	3429						
PAYT 10	16.6	1657	8.1	3016	10.5	2901	13.0	2517	8.0	3651						
MFAYT01	14.2	1257	10.0	2351	8.2	2132	11.0	1721								
PEYT01	10.7	1912	10.4	2898	6.4	2721	10.3	2736	8.0	3621	12.1	2149	5.4	1393		
PEYT02	8.5	2005	5.7	3245	6.2	3040	12.1	2673	9.0	3860	16.6	2367	7.8	1374		
PEYT03	14.2	1850	8.2	2990			6.8	2521	7.0	4055	18.6	2286	8.4	1269		
PEYT04	15.1	1374			9.9	2814	8.2	2466	6.7	3863			10.1	1524		
MFEYT01	10.4	1652	7.9	2627	12.6	2263	18.3	1832								
PSEYT			11.4	2853											17.6	2299.0

Table 4. Summary of coefficients of variation (CV) for yield and yield (kg/ha) in CDC lentil advanced, elite and coop trials in 2008

	Pasqua		Kyle		Sutherland		Rosthern		Wilkie		Elrose		SPG	
Test	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha
LAYT 01	8.3	1702	7.3	1527	9.4	3513	7.1	2767	8.6	3044				
LAYT 02	13.9	1191	8.6	1443	8.4	3164	5.0	2569	5.9	2937				
LAYT 03	12.3	1216	6.9	1592	8.0	3082	6.6	2482	15.8	2433				
LAYT 04	11.8	1319	7.4	1732	11.9	3343	5.2	2854	8.9	3041				
LAYT 05	9.9	1363	9.1	1860	12.0	3469	6.0	2751	8.4	3166				
LAYT 06	24.0	989	5.8	1942	6.6	3409	5.2	2595	12.0	2554				
LAYT 07	18.2	1063	5.7	1656	9.2	3182	6.2	2491	10.9	2884				
LAYT 08	12.0	1516	4.8	1600	6.0	2941	6.0	2358	12.2	2742				
LAYT 09	14.3	1160	5.7	1617	7.0	3008	7.1	2159	9.2	2398				
LAYT 10	19.4	909	7.3	1675	10.4	2908	9.0	1918	7.8	2633				
LAYT 11	13.4	1209	3.2	1734	7.1	2450	9.0	1766	11.4	2422				
LAYT 12	16.0	1023	8.0	1690	11.0	2591	19.5	2193	12.1	2452				
LAYT 13	13.4	1218	7.5	1548	10.0	3279	6.0	2629	13.6	2920				
LEYT01	8.2	1759	4.2	1640	4.9	3136	9.0	2067	11.6	2314	6.8	1387	12.2	1892
LEYT02	10.9	1649	6.0	1666	5.0	3818	8.0	2947	13.0	2647	9.5	1390	11.0	2004
LCYTA	10.0	1643	7.0	1883	8.0	3489	6.0	2726	13.0	2785	8.0	1396		
LCYTB	22.0	1559	6.0	1721	7.0	3248	8.0	2268	19.5	2227	13.0	1352		
LCTYC	17.0	1412	8.0	1639	11.0	3260	8.0	2445	12.0	2485	9.0	1344		

Table 5. Summary of coefficients of variation (CV) for yield and yield (kg/ha) in CDC bean advaced, elite and coop trials in 2008

	Skarsgard		Oxbow		Rosthern		Outlook	
Test	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha	CV	Kg/ha
BAYT 01	10.6	2193	12.6	1387	10.5	1569	6.4	3185
BAYT 02	12.0	2014	15.9	1315	19.6	1516	9.5	2829
BAYT 03	10.6	2169	13.7	1114	17.7	1423	6.0	2839
BAYT 04	11.3	2003	15.9	1182	10.7	1146	7.4	2803
BAYT 05	19.5	1614	19.0	945	14.2	1212	6.4	2736
BAYT 06	10.8	2105	13.3	963	11.3	1301	5.6	2629
BAYT 07	13.1	1949					5.4	2914
BEYT01	15.0	2092	16.0	1529	12.0	1536	7.0	2696
SSNRAB	11.8	2261	17.2	1281	17.6	1353	11.9	3063

In single replicate yield trials such as the pea preliminary trials at Meath Park and the lentil preliminary trials at Pasqua, CV's cannot be calculated. As one measure of reliability of the data, mean yields of the check varieties were calculated (for example, see Table 6). In pea preliminary yield trials at Meath Park, mean yields were moderate (~2.5 tonnes/ha or ~40 bu/acre) similar to the grower yields in the area. Yields were slightly lower than those at the Sutherland (Saskatoon) site. Similarly, in lentil preliminary yield trials at Rouleau, mean yields were moderate (~1.5 tonnes/ha or ~20-25 bu/acre) similar to grower yields in the area, and slightly less than yields at Sutherland.

Table 6. Summary of grain yield (kg/ha) of check varieties in pea preliminary yield trials at Sutherland (Saskatoon) and Meath Park in 2008.

	Sutherland		Meath Park	
Variety	**Yield**	**% Cutlass**	**Yield**	**% Cutlass**
Cutlass	3390	100	2627	100
Eclipse	3073	91	2451	93
CDC Meadow	3361	99	2865	109
CDC Striker	2971	88	2715	103
CDC Sage	2806	83	1903	72

In summary, the on-farm pulse germplasm evaluation approach was useful in meeting the objectives of this proposal. If desired, further details on the results of individual 2004-2008 trials are available from the authors of this report. This research project proceeded on schedule.

Reference

Varieties of Grain Crops 2009. Saskatchewan Agriculture and Food.

d) Project progress

This project was initiated in 2004 and ran for a total of five years. Section c) summarizes the project progress in 2008. Progress in 2004-2007 was reported in previous annual reports.

e) Administrative and other aspects

Papers/presentations:

Oral presentations at which this project was mentioned in 2008:

- SAF/SPG Pulse Extension Meeting on February 5, 2008 at Swift Current, SK.
- SAF/SPG Pulse Extension Meeting on February 6, 2007 at Moose Jaw, SK.
- SAF/SPG Pulse Extension Meeting on February 7, 2007 at Weyburn, SK.
- Saskatchewan Pulse Growers/Select seed growers tour at Saskatoon, SK on July 24, 2008.

Information of benefit to producers, processors, or governments:

In 2008, this project effectively evaluated approximately 4700 lentil, pea, and dry bean breeding lines (F4-F7 generations) (total of 7839 plots) from the CDC program at a series of sites outside a 150 km radius of Saskatoon. All trials were conducted on pulse grower farms and general plot maintenance was conducted primarily by the farmer co-operator. Average cost per plot was approximately $10. This system allowed for effective evaluation of breeding lines and will be useful in selecting lines for re-evaluation in more advanced trials in 2009 and future seasons. This project accelerated the release of superior pulse crop varieties for the Saskatchewan industry. Recently released varieties include: CDC 1410-15 yellow field pea (2009), CDC Patrick green field pea (2008), CDC Leroy silage pea (2008), CDC Prosper small yellow field pea (2008), CDC Centennial yellow field pea (2007), CDC Meadow yellow field pea (2006), CDC Tucker forage pea (2006), CDC Rocket maple pea (2006), CDC IBC 112 small green lentil (2009), CDC IBC 145 medium green lentil (2009), CDC IBC 194 large green lentil (2009), CDC 1894-1 extra small red lentil (2009), CDC 2154-4 small red lentil (2009), CDC IBC 187 small red lentil (2009), CDC IBC 188 French green lentil (2008), CDC 2471 medium green lentil (2007), CDC 3114 small red lentil (2007), CDC Impact small red lentil (2006), CDC 1308M-7 medium red lentil (2007), CDC Imperial extra small red lentil (2006), CDC 3110 extra small red lentil (2007), CDC Improve CL large green lentil (2006), CDC Greenland large green lentil (2006).

Personnel:

Technical assistance from Chandra Bandara, Lien Tang, Helen Atuku and Monireh Alizadeh was charged to this project in 2008.

Equipment purchased: None

Project Developed Materials:
Many pulse crop breeding lines have been evaluated as described in the tables attached to this report. These lines arose from the CDC pulse breeding program.

Project Photos:
Numerous photos were taken by Warkentin and Vandenberg at various trial sites in 2004-2008. These are available on request.

Acknowledgement:
The Saskatchewan Agricultural Development Fund and the Saskatchewan Pulse Growers were acknowledged in all presentations where this research project was mentioned.

Expense Statement:
Will be provided.

f) ICAR Data Entry
Will be entered.